Contour Diagrams of Dielectric Loss for Absolutely Dried Spruce Wood

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Preliminary

Contour Diagrams of Dielectric Loss for Absolutely Dried Spruce Wood*[1]

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In absolutely dried wood, the dielectric relaxation process due to the motions of methylol groups in the amorphous region of the cell wall is observed over the wide range of frequency at room temperature[1,2]. The dielectric loss maximum in this relaxation process locates at around 10 MHz.

The aim of this study is to obtain the contour diagram of dielectric loss in this relaxation for spruce *(Picea sitchensis)* wood. For this purpose, the dielectric constant and the dielectric loss of absolutely dried spruce wood along the grain were measured at 50 Hz, 110 Hz, 1 kHz, 10 kHz and 100 kHz over the temperature range from −160°C to room temperature.

Figure 1 showed the relationships between dielectric losses at respective frequencies and temperature. The occurrence of the relaxation process due to methylol groups was evident within the experimental temperature range at each frequency. The logarithm of frequency at the dielectric loss maximum against the reciprocal of absolute temperature was plotted by closed circles in Figure 2. There was an excellent linear relationship between them. The apparent activation energy calculated from the slope of the straight line according to the theory of absolute reaction rate[3] was 9.8 kcal/mol.

The Cole-Cole arc plot[4], in which dielectric loss is plotted against dielectric constant, was attempted. The loci showed depressed semicircles, thus the Cole-Cole equation could be fitted to the experimental results. From the Cole-Cole plot, the generalized relaxation time, the parameter relating to the distribution of relaxation times and the relaxation magnitude were determined. In Figure 2, the relationships between the logarithm of frequency at the dielectric loss maximum in the Cole-Cole plot and the reciprocal of absolute temperature were shown by open circles. There was an excellent linear correlation between them. The apparent activation energy calculated from the slope of the straight line was 9.8 kcal/mol. The value obtained from the frequencies at maximum loss in the constant

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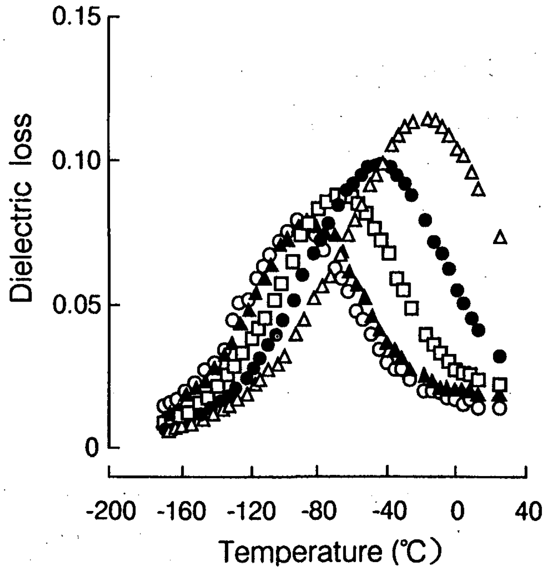

Fig. 1. Relationships betweem dielectric loss along the grain at respective frequencies and temperature for absolutely dried spruce wood. Legend ; ○: 50 Hz, ▲: 110 Hz, □: 1 kHz, ●: 10 kHz, △: 100 kHz

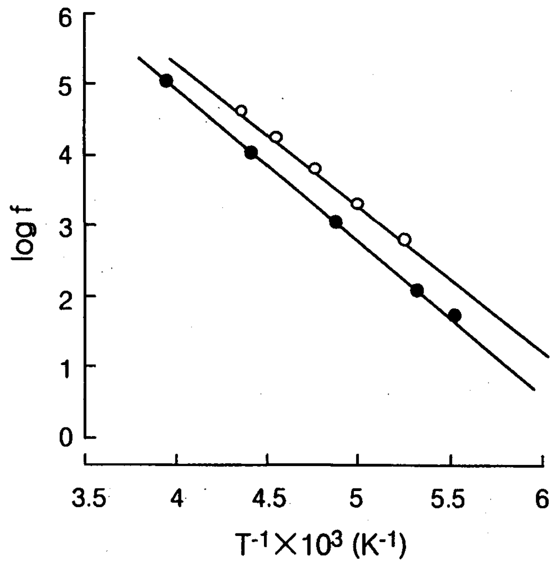

Fig. 2. Relationships between logarithm of frequency (log f) at loss maximum and reciprocal of absolute temperature (T^{-1}) for absolutery dried spruce wood. Legend ; ●: obtained from dielectric loss versus temperature curves at respective frequencies, ○: obtained from Cole-Core plots.

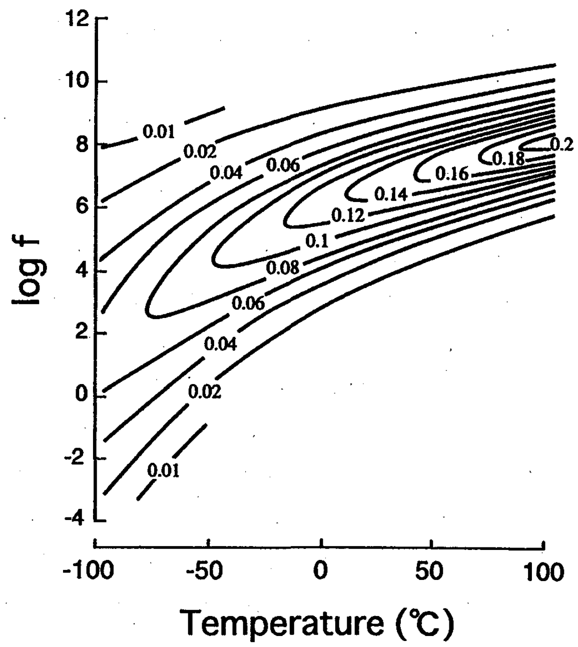

Fig.3. Contour diagram of dielectric loss for absolutely dried spruce wood.

temperature measurement coincided with that obtained from the temperatures at maximum loss in constant frequency measurement. The parameters in the Cole-Cole equation were expressed by a linear function of temperature within the temperature range tested. By extrapolation, these parameters were determined over the temperature range from $-100°C$ to $100°C$. Using these parameters, the dielectric loss was calculated over the wide range of temperature and frequency. Figure 3 showed the contour diagram of dielectric loss.

References

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